REPORT

on

ET-2 ELECTROMECHANICAL TRANSMITTER

(W.O. 570)

June 28, 1957

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I PURPOSE

The purpose of this investigation was to evaluate and study the present ET-2 transmitter, to recommend the steps necessary to make the equipment reliable, and to estimate the cost of producing a small quantity of reliable equipments.

II SUMMARY

The system used to record the Baudot code on magnetic tape is well known in the telemetering industry and has been used quite successfully there. No attempt was made to revise the system concept, since this appeared satisfactory. It appears uneconomical, however, to try to use the present design of the subassemblies in any repackaging project.

The following refers to the five main subsections of the unit:-

1. Keyboard

It is believed that the present electrical keyboard is inherently unreliable. A mechanical counterpart along general lines of teletypewriter technique has been "breadboarded" and the principle has been proved.

2. Power Supply

The power supply was carefully scrutinized and considerable circuit revision is suggested.

3. Electronics

The electronics circuitry appears satisfactory with minor changes suggested. A repackaging is desirable to get mechanical arrangements which are less flimsy.

4. Drive System

The drive system is entirely unsatisfactory. Any attempt to produce even a small quantity in this configuration would be costly and completely unreliable. A revised drive system is suggested.

5. Tape Transport

The tape transport and storage system require only minor improvements.

A cost estimate for engineering and making a small quantity is included in this report.

III EVALUATION AND RECOMMENDATIONS

1. Keyboard

The present unreliable and complex keyboard requires a complete redesign. The multiplicity of electrical connections contributes to an inherent decrease in reliability. The fragile construction compounds this effect drastically. A preliminary redesign and "breadboard" assembly proves that a simple group of mechanical code plates will be much more rugged and much less costly to reproduce. It will also lend itself to a more compact construction. The enclosed photographs illustrate the construction.

Five code plates are restrained so that they can move along only one axis. In each plate are drilled holes, one for each character on the keyboard. Some of the holes are on the same centerline as the keys. Others are displaced a given amount either side of these holes. Those on the centerline represent no signal to the tape. Those that are offset represent a positive or negative pulse on the tape. Each code plate has associated with it a single-pole, double-throw, off-neutral switch. The key shaft is essentially a multiplicity of cams, one cam for each code plate. As the key is depressed, the code plates are deflected in the proper directions. The switches are then also actuated. The signal from the switches can then be scanned by the commutator and recorded on the tape.

A sixth plate is used to latch the depressed key. This plate can be interlocked with the tape transport mechanism so that a second key cannot be depressed before the mechanism has completed its cycle, if necessary.

It is believed that this proposed mechanical keyboard will be simpler, more compact, more reliable, less expensive to produce and will require less engineering than the present electrical assembly. The general mechanical principles used are similar to those used in teletypewriters and, therefore, are not a major departure from known arts.

2. Power Supply

An extensive study of the power supply circuitry revealed that considerable space could be saved by revising the high voltage supply from a half wave to a full wave bridge circuit. While this requires the addition of a rectifier element, it allows a substantial reduction in the size of the filter required. It also allows more efficient transformer operation.

The power supply for the motor, solenoid and relay can easily be converted to 6 volt full wave centerlap operation, again providing more efficient filtering. This can be done if the suggestions for a motor revision, which follow, are carried out.

Unless a larger number of taps are provided on the power transformer, the vernier rheostat will have to be increased in current carrying capacity. In the present equipment it is possible to overload the rheostat on the 60 volt setting of the switches.

It is our understanding that the self contained live keying voltage supply is no longer necessary. If so, it should be eliminated. However, provision for this supply has been made available, if it is found to be desirable. Figure 1 shows a

circuit of the proposed power supply.

3. Electronic Section

The electronic circuitry seems to function satisfactorily. The signal to the output stage, as measured, is a little below nominal. However, with some circuit revision, (no addition of tubes), the reliability should be improved. Some erratic operation was noted due to noise pulses from the drive motor. If more energy is recordedon the tape by the use of larger tank capacitors in the commutator circuit, the signal from the tape in the transmit-mode can more easily be distinguished from these noise pulses. Filtering on the motor is also necessary to reduce motor R.F. noise radiation.

The automatic stop feature which utilizes a brush on the tape to prevent double recordings can be revised both mechanically and electrically to provide higher reliability. The circuitry uses a fragile 28 volt lamp as a resistor whose resistance varies with time as a voltage is impressed across it. It is recommended that a change be made to use a resistor-capacitor combination. Exactly the same results were achieved in a "breadboard" with these much more rugged components. See Fig. 2 for a simplified circuit of this change.

4. Drive Assembly

In Fig. 3 a sketch of the drive assembly shows a D.C. motor, a speed reducer, a one revolution spring clutch controlled by a solenoid and the commutator. The D.C. motor is of the type used in present day miniature tape and disc recorders produced for dictating purposes. These motors are very reliable compared to

the Haydon Chronometric type used in the present model. Although they may not have the precise absolute speed control of the Haydon motor, they are far superior with regard to flutter and wow. They are also much more compact and rugged.

A simple gear reducer couples the high speed motor shaft to a counter shaft thru the one revolution spring clutch. These spring clutches are commercially available. They have a very high ratio of engaged to disengaged torque. This clutch would be actuated by a solenoid. The signal for the solenoid would come from the sixth plate in the keyboard mechanism which momentarily closes a switch when a key is depressed after the code has been set up.

No.- To much noise bkm

In the present equipment no provision is made to interlock the keys so that a signal from one will not try to overlap that of another. This could be caused by depressing two keys in quick succession. This possibility can be eliminated, if desired, with the proposed construction but it is suggested that even this simple complication is not necessary. It is not visualized that any difficulty will be experienced with this because the operator can see and hear when the cycle is completed.

In the transmit and erase modes, the solenoid will be engaged electrically by the closure of a switch on the front panel. This will replace the poorly designed mechanical latch on the present equipment.

The commutator is shown below the clutch assembly. It need not be nearly so complicated as the one on the present equipment. Only seven commutator segments should be necessary. Note the accessability for servicing. A commutator could be replaced in

minutes. Fig. 4 shows a simplified circuit of the commutating section.

5. Tape Transport

Fig. 3 also shows the tape storage chamber and the tape transport. The record-reproduce head and the erase head are mounted similar to the ET-2 construction. Idlers and tension pads will also be similar although improved. It appears as if much less tape storage space is required than is present on the ET-2. It is suggested that the space be reduced to about 4" x 6" x 1/2" overall.

6. Packaging

It is proposed that the unit can be packaged in a 4" x 6" x 9" box such as shown in photograph No. 1.

Photograph No. 2 shows an illustrative model constructed during this study. All the component parts are mounted on a top plate. This lends itself to rugged construction when the components are also braced to each other. The keyboard and code plates are shown in the foreground. Some of the electronic circuitry is visible and blocks of wood were used to simulate the spaces for the drive mechanism and tape storage.

Photograph No. 3 reveals the accessability provided for servicing. It is intended that the bottom electronic assembly be removable to allow even greater accessability when necessary.

The keyboard and the drive mechanism are completely isolated assemblies and can be removed for servicing.

Photographs No. 4 and No. 5 shows the present ET-2, and comparison of photos will show the improvement in construction techniques and in the servicing problems which can be accomplished.

7. Estimate of Cost of Improved Units

It is estimated that the proposed changes can be made, a complete set of working drawings produced, and a model be constructed as per the above detailed recommendations for approximately $17,000.

Additional models in lots of 1 to 6 would cost approximately $3,000. each. In numbers from 6 to 20 units, the estimate would be $2,500. each.

gs

BY JDH DATE 6-26-57 ET-2 TRANSMITTER OF

CHKD. BY DATE REV. PWR. SUPPLY JOB NO.

FIGURE 1

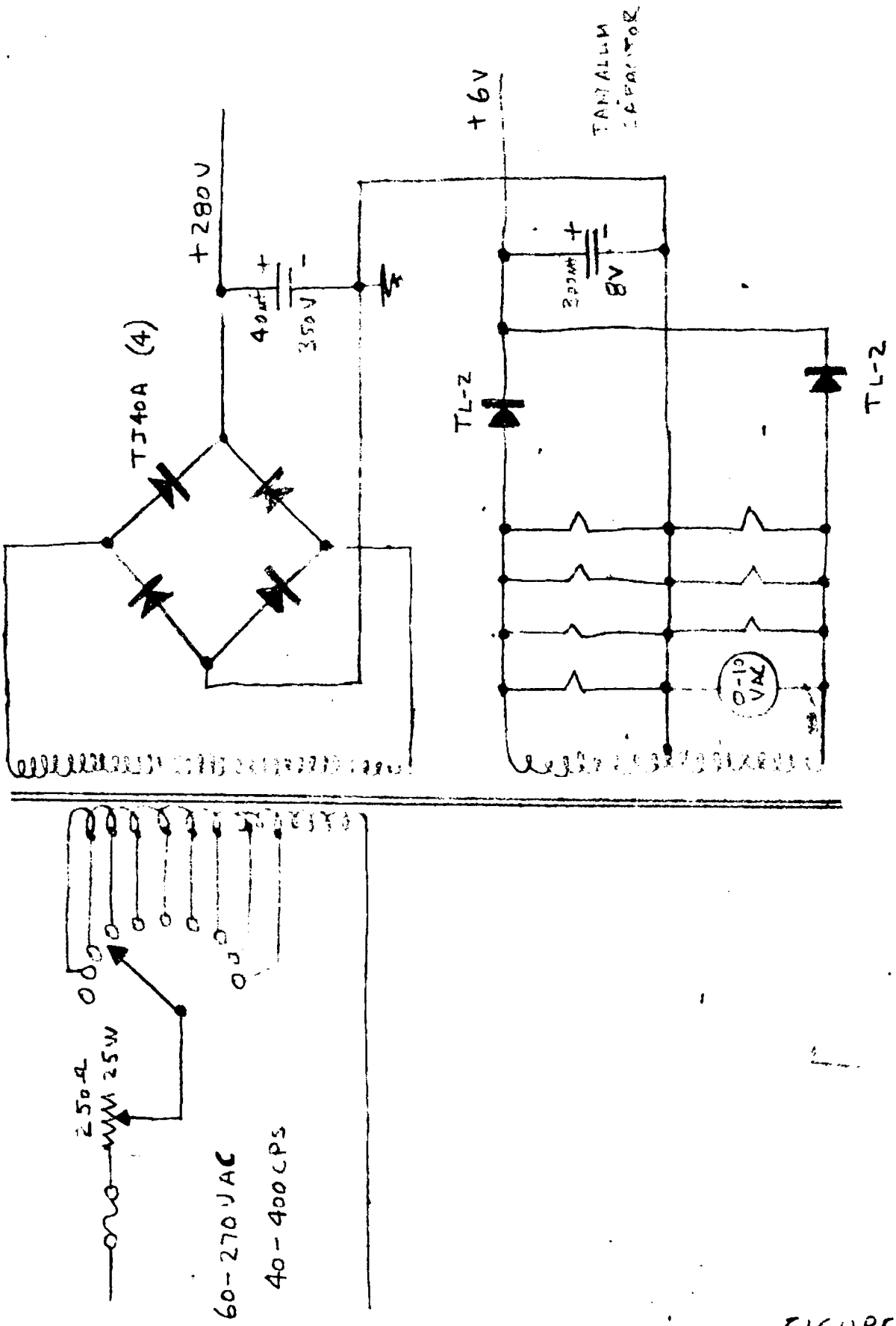


FIGURE 1

BY TDH DATE 6-26-63 OF

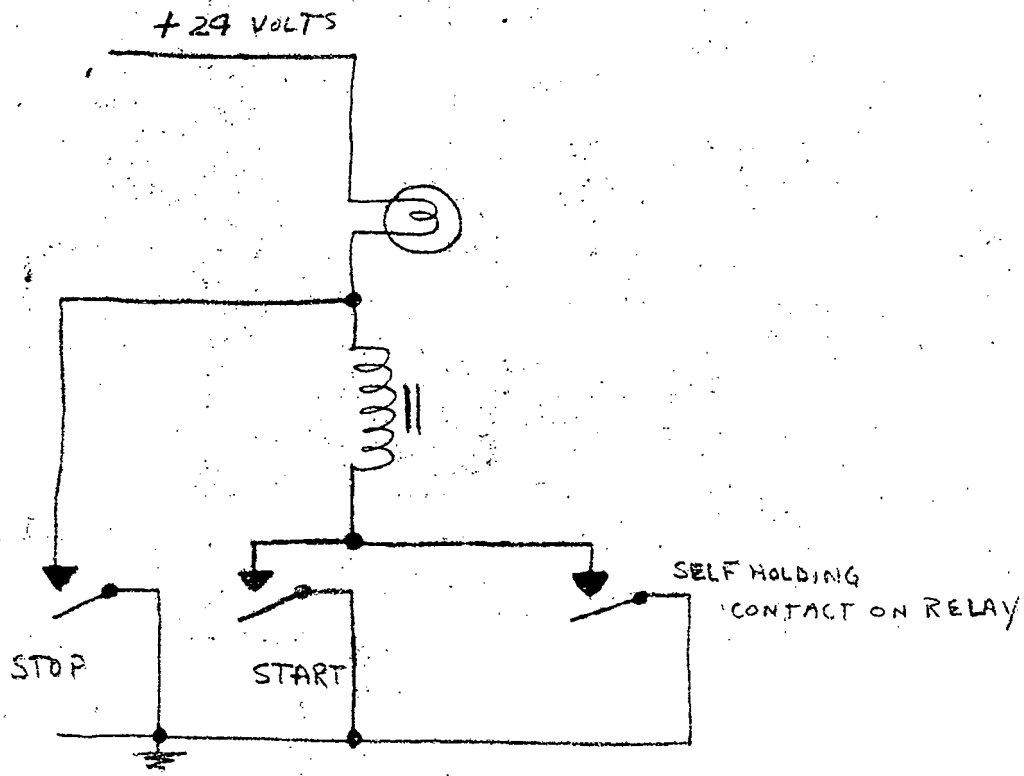
CHKD. BY DATE

RELAY CIRCUIT CHANGE

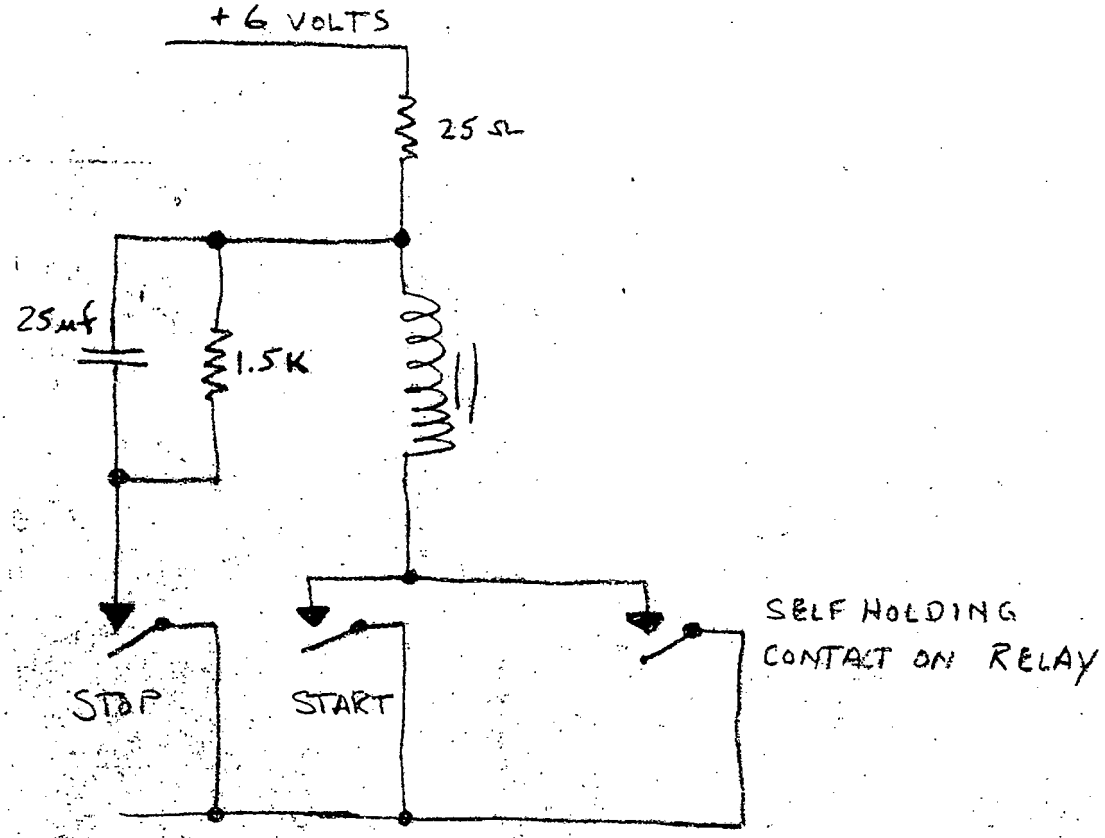
PROPOSED

JOB NO.

FIGURE 2



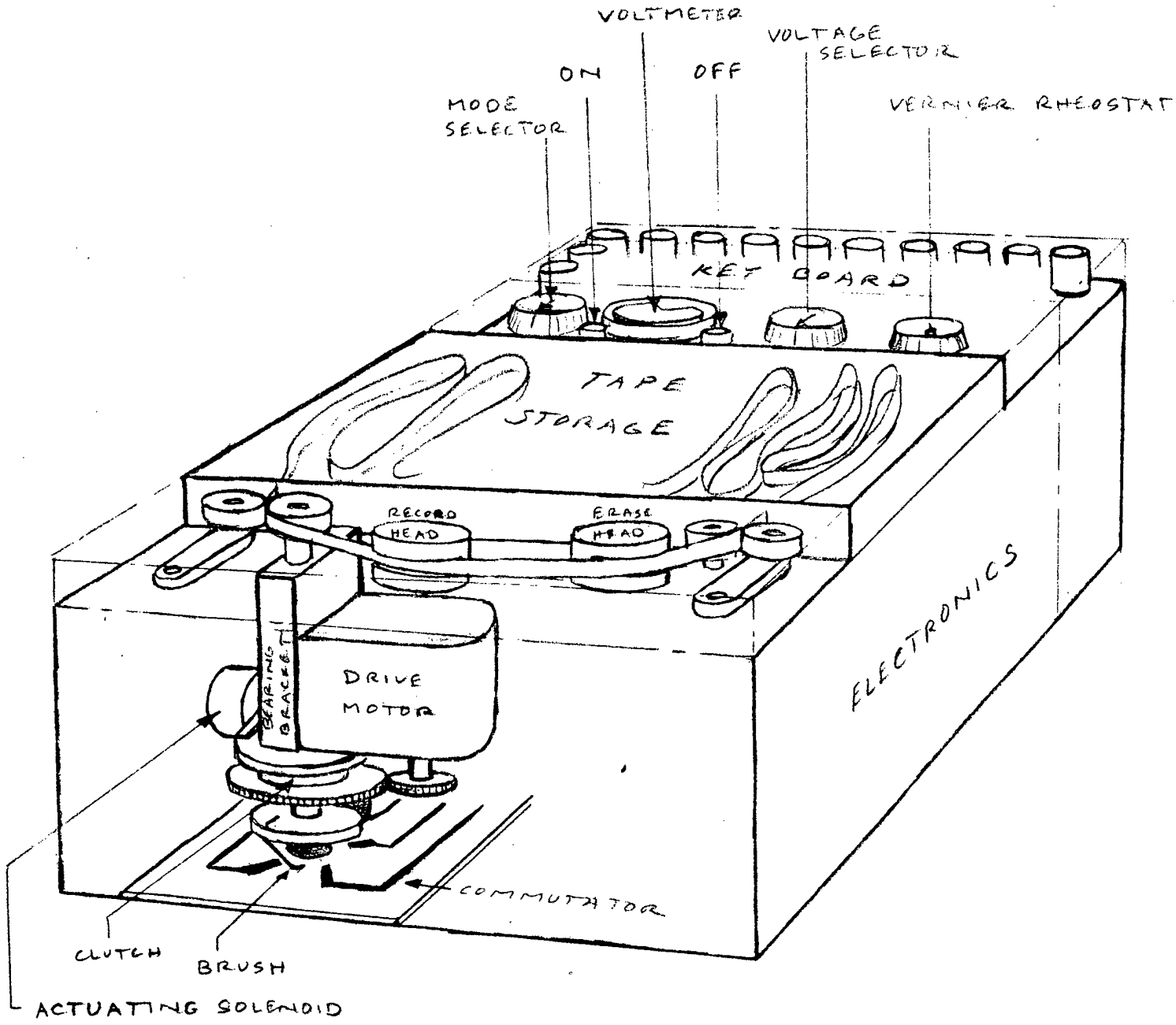
(A) SIMPLIFIED CIRCUIT OF PRESENT METHOD.



(B) PROPOSED RESISTANCE-CAPACITANCE METHOD.

FIGURE 2

P. PROPOSED MODIFICATIONS TO KEYER



MOMENTARY CONTACT FROM KEY BOARD RELEASES SHAFT FOR ONE REVOLUTION WHEN WRITTING. SOLENOID IS ENERGIZED CONTINUOUSLY DURING TRANSMITTING.

FIG. 3

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COMMUTATOR CIRCUIT REVISION

JOB NO. FIGURE 4

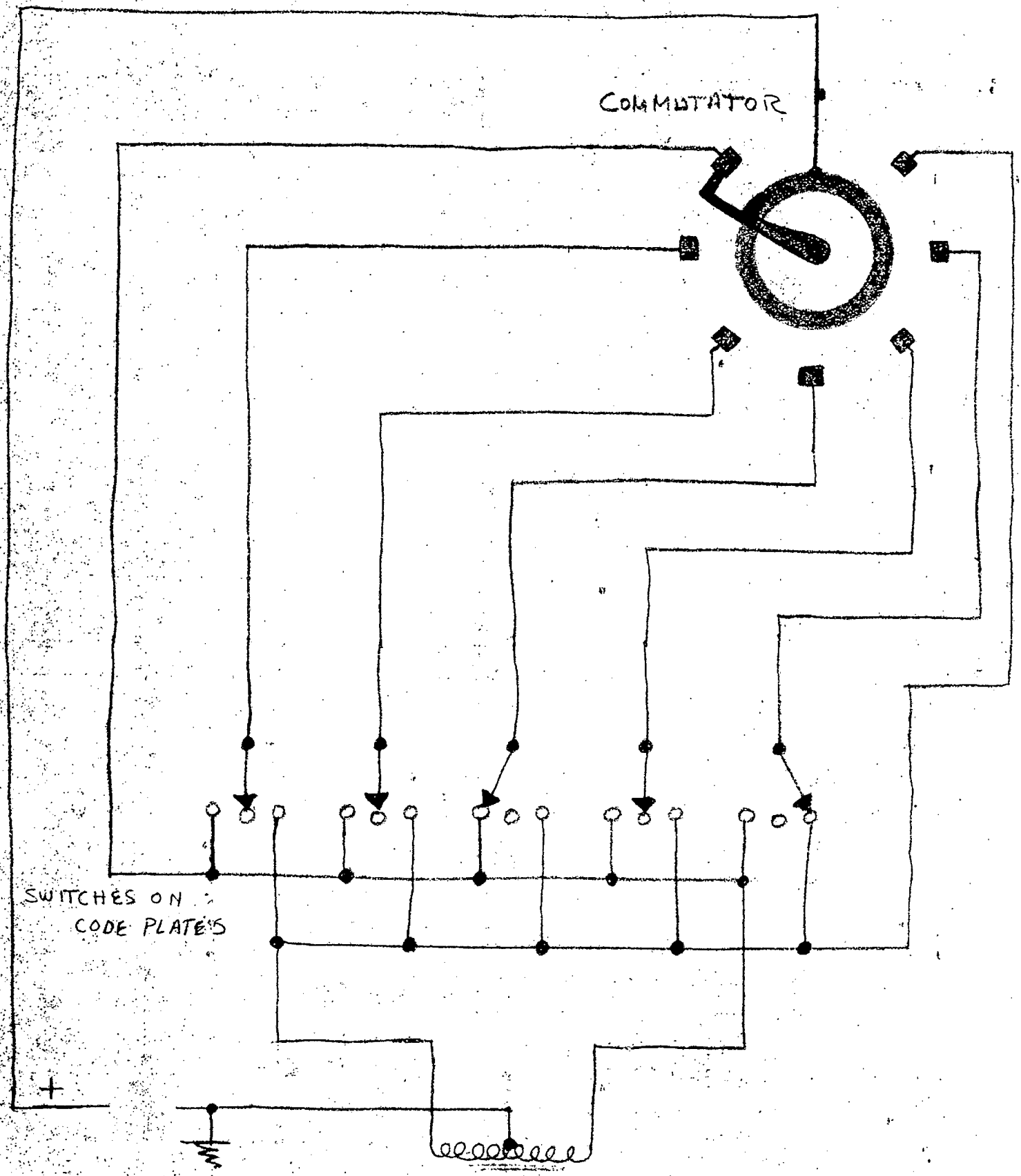
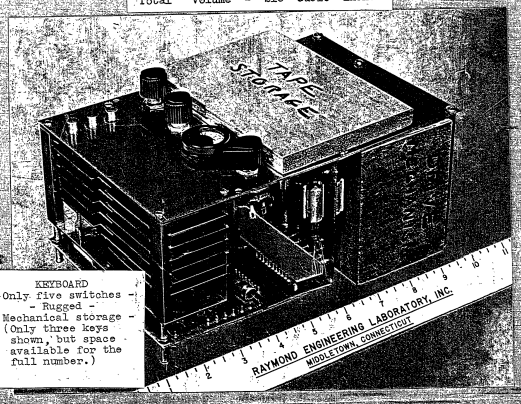


FIGURE 4

PROPOSED DESIGN

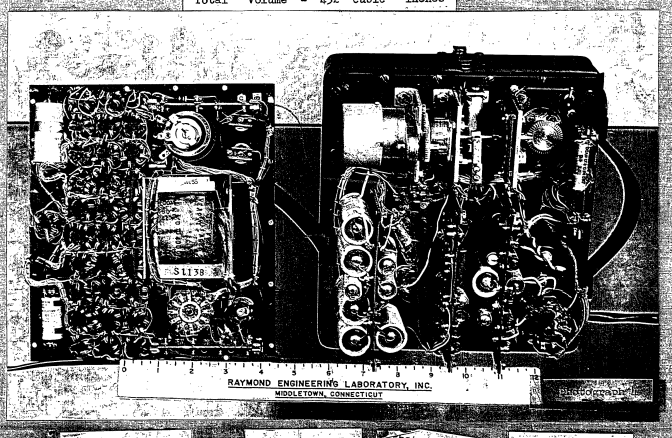
Total Volume - 216 cubic inches



KEYBOARD
- Only five switches -
- Rugged -
- Mechanical storage -
(Only three keys shown, but space available for the full number.)

PRESENT DESIGN

Total Volume - 432 cubic inches



DRIVE MECHANISM

POWER SUPPLY

Photograph 5

for servicing

COMPACT

POWER SUPPLY